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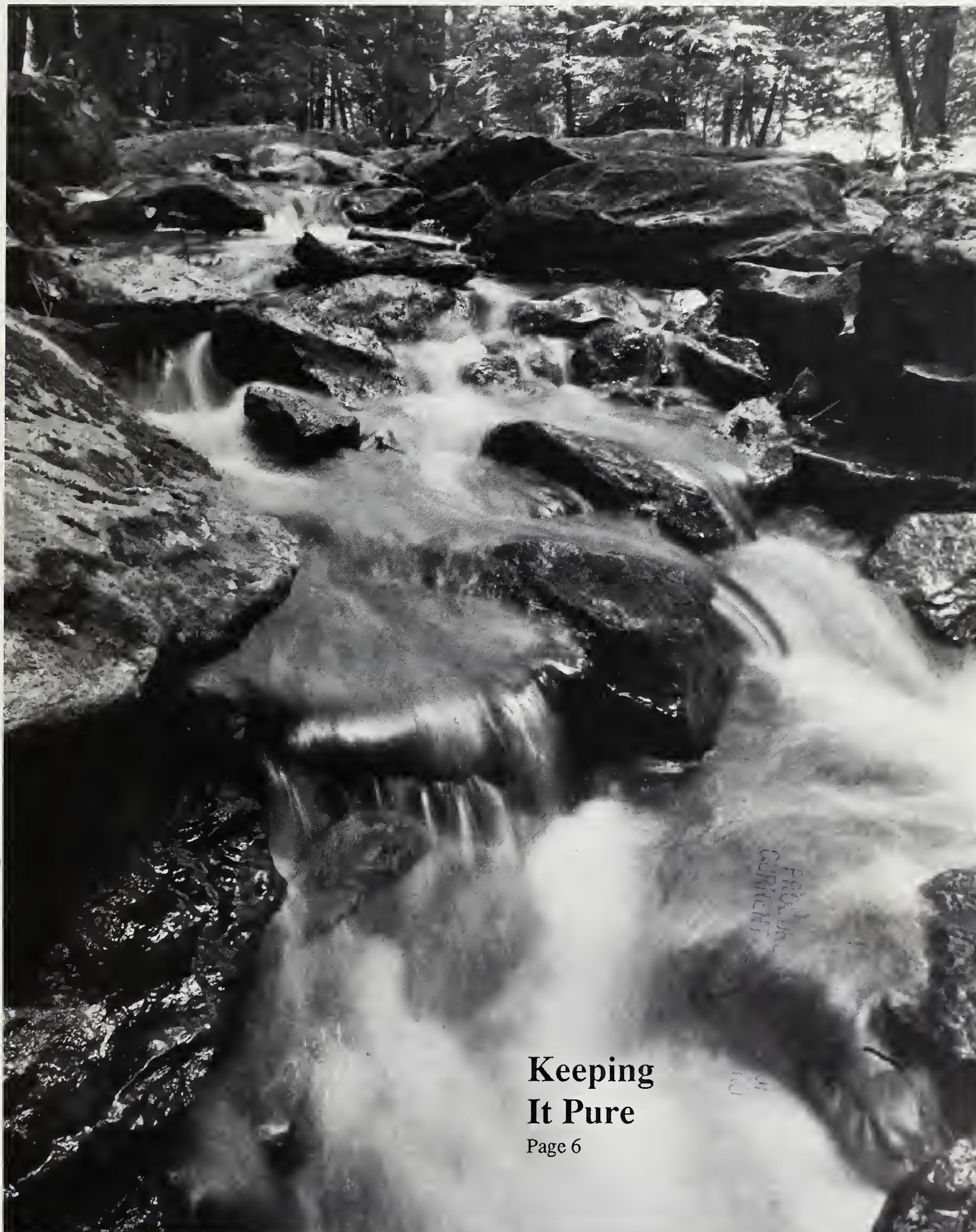
Agricultural Research



Keeping It Pure

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Improving Groundwater Quality

A host of wastes enter the nation's underground water supply from sources ranging from septic tanks, cesspools, and leaky sewers to runoff from salted highways, landfills, and industrial spills. Scientists and the general public alike are uneasy about the presence of contaminants in our groundwater, even though quantities may be exceedingly small.

Because seepage from agricultural sources represents only one aspect of a complex problem, the U.S. Department of Agriculture is among a number of agencies addressing groundwater quality. USDA's Agricultural Research Service is allied with the U.S. Environmental Protection Agency and the Department of the Interior's Geological Survey, as well as state and local agencies. Outside of government, many different groups have voiced concern about the quality and safety of groundwater.

At ARS, we are working to identify potentially harmful chemicals used in agriculture and, to the maximum extent possible, prevent their movement into groundwater. At the same time, we must ensure that American agriculture remains productive and competitive in world markets.

This explains why, for the second straight year, ARS has assigned its highest research priority to improving the quality of groundwater. The primary objective of our program is to develop better strategies for producers to use in managing pests, chemicals, soils, water, crops and animals to minimize groundwater contamination.

Other goals include:

• Improving our understanding of the form, fate, and behavior of inorganic and organic substances as they wash downward from the land's surface, eventually entering groundwater.

• Developing computer models that can predict the effect of changes in chemical management, soil and water management, and crop production systems on groundwater quality.

This month's feature, *Safeguarding Our Essential Resource . . . Water,* offers a quick tour of 14 facilities from California to Pennsylvania and from Georgia to Minnesota where groundwater quality research is conducted. Scientists describe the wide range of options they are evaluating, including changes in irrigation practices and tillage practices, new crop rotations, and changes in the timing, placement, formulation and rates of application of agricultural chemicals.

In one novel project, ground-penetrating radar is being used experimentally to reveal the pathways that water and associated chemicals take as they move through the soil. Another team of scientists uses genetic engineering technology to make micro-organisms better able to break down pesticide residues before disposal. We're not only learning how to prevent contamination, but also finding ways to hurry along nature's own decontamination processes.

We still have more questions than we have answers, but I believe we have made considerable progress in asking the right questions.

Can research help change farming practices? Fall applications of fertilizers, for example, are often more convenient for the farmer. But it's believed that chemicals applied in the fall begin leaching out of the surface layer before the spring crops are planted. The result: Lost nutrients and a greater risk of the chemicals reaching groundwater.

Our challenge is to find the most effective use of chemicals in production agriculture while keeping them out of groundwater.

Can research improve the efficiency of application technology? For a variety of reasons—volatility of chemicals, capricious winds, chemicals falling on the soil instead of on the plant canopy—it has been estimated that only about 2 to 3 percent of some pesticides actually reach their intended targets.

It would be wrong to conclude from this that all—or even a very high percentage—of the off-target pesticides reach our water supplies. Still, it is reasonable to assume that improving the efficiency of pesticide application technologies will reduce the loading of pesticides into our environment, including groundwater.

What happens to the agricultural chemicals applied in a field? And by extension, how effective are the various strategies that have been proposed to restrict chemicals to the zones intended? This is an area in which we may be farthest along. Our computer models are beginning to give us some answers.

We do not know all the answers. But it's important that we continue taking positive steps toward achieving lasting solutions. When you consider that almost half the people in the United States are dependent on groundwater for drinking water—and that groundwater furnishes one-fourth of the nation's entire fresh water usage—you can appreciate the value of this poorly understood resource, and you can see why ARS has made groundwater quality its number one priority.

Terry B. Kinney, Jr., Administrator
(Adapted from remarks at a workshop on groundwater quality sponsored by the Agricultural Research Institute at Annapolis, Maryland, November 2, 1987)

Agricultural Research

Cover: Streams such as this one near Thurmont, Maryland are a source of recharge for groundwater supplies. Across the country, Agricultural Research Service scientists are examining the impact of farming practices on surface and groundwater quality. Photo by Ron Nichols, Soil Conservation Service. (88BW0085-5)

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DEPARTMENTS

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Agricultural Research Service

Caterpillars Held in Perpetual Youth

A tiny parasitic wasp that lays its eggs on the skin of unsuspecting caterpillars also makes lethal chemical crystals. These crystals could be the source of a new insecticide, says an Agricultural Research Service scientist in Columbia, Missouri.

"The crystals contain a chemical arrestant that stops an insect in its caterpillar or larval stage from molting—shedding its skin— so it can't develop into an adult," says chemist Thomas A. Coudron.

The female *Euplectrus plathypenae* wasp injects the crystals, not to kill the host, but rather to ensure the survival of its own young. Although most parasitic insects live within the bodies of their hosts, juveniles of this species begin their lives on the outer skin of their hosts, which they then eat. Were the host insect to molt, juvenile wasps would be separated from their living food source.

The wasp's ability to arrest the host's development, thus bringing about its demise, has fascinating implications for scientists who battle crop pests.

In the laboratory, Coudron has isolated the crystals from wasps and stopped growth in several species, including the bollworm, fall and yellowstriped armyworm, cabbage looper, asparagus beetle, and common green lacewing by injecting the crystals. His next step is to identify the chemical arrestant in the crystals, which are found in the wasp's reproductive tract.

Coudron is conducting studies to determine if the chemical arrestant is as potent when insects eat it as when it is injected into their blood. If so, perhaps it could be sprayed on crops, like many conventional insecticides and biological control microbes.

Coudron works with entomologist Benjamin Puttler, also with ARS in Columbia. "One advantage to these crystals," says Puttler, "is that they affect an insect while it is still developing, rather than after it becomes an adult. A leaf-eating insect does at least 90 percent of its damage during its larval or caterpillar stage."

In the search for new safe and effective ways to control pests that every year cause millions of dollars of damage to corn, wheat, soybeans, and forage crops, the two scientists are studying many insects and their parasites.

Puttler, an internationally recognized entomologist, is an authority on wasps. In fact, two South American species that have been brought into the United States are named after him. One of these, *Edovum puttleri,* attacks eggs and larvae of the Colorado potato beetle, a pest that eats tomatoes and eggplant, as well as potatoes. Another, *Euplectrus puttleri,* feeds on larvae of the velvet bean caterpillar, a pest of soybeans and other legumes in the southeastern United States.—By **Linda Cooke,** ARS.

Thomas A. Coudron and Benjamin Puttler are in the USDA-ARS Biological Control of Insects Laboratory, P.O. Box 7629, Research Park, Columbia, MO 65205. Phone (314) 875-5361. ♦

Culprit in Winter Lettuce Price Rise

A virus spread by whiteflies has caused lettuce prices to triple in markets nationwide. But scientists say growers may be able to outmaneuver the sweetpotato whitefly until new disease-resistant lettuce varieties can be bred.

Agricultural Research Service scientists are working with several wild lettuce varieties that appear to be immune to infectious yellows virus, says Howard J. Brooks, national program leader for horticultural and sugar crops for the agency at Beltsville, Maryland.

He says ARS researcher James D. McCreight at Salinas, California, has found 15 strains of wild lettuce—from Portugal, Israel, Turkey, Greece, and other parts of the world—that appear to be naturally resistant to the virus.

Lettuce leaf with infectious yellows virus. (PN-7270)

But, Brooks says, it could take 6 to 10 years to breed resistant varieties adapted to the desert climate of California and Arizona, where most of the U.S. winter lettuce crop is grown. In the meantime, growers may be able to outsmart sweetpotato whiteflies by destroying virus-infected weeds that harbor flies near lettuce fields.

The region was hard hit by an outbreak of the virus-carrying whiteflies last September. The infectious yellows virus causes leaves of young lettuce to turn yellow or red and stunts growth. It attacks iceberg or head lettuce as well as leaf lettuces such as romaine, butter, and red leaf.

"Pesticides aren't an effective way to get rid of the whitefly because the insect lives on the undersides of leaves where it's hard to spray," says James E. Duffus, an ARS plant pathologist at Salinas. "Even if a whitefly were hit by insecticide, it may still live long enough to transmit the virus. Also, the whitefly has a natural waxy coating, so much of the pesticide spray just rolls off.

"We already know that the whitefly can live in at least a dozen different weeds, such as dandelion, wild beet, morningglory, and others, but we need to determine which of these the insect and virus favor.

"Then we need to convince growers throughout the southwest farming areas to get rid of these

particular weeds during the critical period when all the winter lettuce has been harvested and the whiteflies are waiting for the melon crop to be planted," Duffus says.

Duffus and scientists at the station and elsewhere in California are pursuing other research to fight the virus, including using modern biotechnology techniques to determine how many lettuce genes are involved in inherited resistance (such as wild lettuce has) and the development of a DNA probe to detect very small amounts of the virus.—By **Marcia Wood,** ARS.

James D. McCreight and James E. Duffus are at the U.S. Agricultural Research Station,USDA-ARS , 1636 East Alisal St., Salinas, CA 93905. Phone (408) 755-2800. ♦

Vaccine Planned Against Cattle Grub

A California biotech firm and USDA's Agricultural Research Service are teaming up to produce the first vaccine against the cattle grub, a costly worldwide agricultural pest.

"We should begin testing a new vaccine in a few months because of a cooperative research agreement with Codon, Inc., of South San Francisco," says John H. Pruett, Jr., a microbiologist with ARS.

Fred Gvillo, Codon's director of corporate development, says, "A vaccine could be commercially available by 1990."

In the United States alone, the grub—parasitic larva of the heel fly—costs hundreds of millions of dollars each year in damaged hides, discolored meat, and other losses.

When heel flies (adult stage of cattle grubs) attempt to lay eggs on the animal's hairs, cattle run to escape them. Not only can they injure themselves, the panic reaction interferes with feeding and breeding. Grubs that hatch penetrate the hide, spending up to 11 months inside an animal.

To make a vaccine, Codon will genetically engineer *Escherichia coli* bacteria to mass-produce a protein found naturally in grubs in small amounts. Pruett and colleagues at the U.S. Livestock Insects lab in Kerrville, Texas, first discovered and isolated the protein that gives cattle immunity to grubs.

"If the vaccine proves effective," Pruett says, "it could offer ranchers a more convenient, longer lasting, and environmentally safer control than insecticides currently in use."

Grub-infested cattle eventually develop a natural immunity, but much damage is done in the meantime. "We want to speed up the natural process, and stop grubs before they cause serious economic losses," Pruett says.

Gvillo expects Codon will be able to tailor the vaccine so it can be administered concurrently with other vaccines or medicines ranchers use routinely.—By **Don Comis,** ARS.

John H. Pruett, Jr., is at the U.S. Livestock Insects Laboratory, USDA-ARS, Kerrville, TX 78029. Phone (512) 257-3566. ♦

Bored Boars: A $50 Million Problem

"At least 35,000 boars, or 20 percent of those used for breeding by commercial pork producers in the United States, don't perform adequately sexually," says J. Joe Ford, an animal physiologist with the Agricultural Research Service in Clay Center, Nebraska.

"But, up till now, there's been no way to identify which boars fall into this category before they are needed to mate with females. That's a $50-million-a-year problem for the pork industry," he says.

Ford and Donald G. Levis, a University of Nebraska extension specialist also at Clay Center, have developed an accurate system to predict whether or not a boar will be suitable for breeding.

"We can systematically identify nonperforming boars as soon as they are sexually mature—about 9 to 10 months old," Ford says. "Identifying young boars that are sexually inadequate will help pork producers avoid wasting money on keeping those that won't perform and save the cost of maintaining females that didn't get pregnant."

"Commercial pork producers have placed considerable emphasis on the sow—her capacity to carry a large litter and to mother pigs. There has been much less emphasis on reproductive potential of boars at the time they are purchased for breeding," says Ford.

In their research to develop a reliable technique for evaluating sexual behavior, they administered three tests to rate each boar's sexual performance .

First, a boar was placed with one sow in heat. His behavior was observed for 5 to 10 minutes. In the second test, the same boar was placed in a pen with three females—two in heat and one not—for 10 minutes. In the third test, the boar stayed with three females for 1 week and sexual behavior was recorded while two of the females were in heat.

According to Ford, the first test is reliable enough to be used alone by commercial producers or breeders of breeding stock.—By **Linda Cooke,** ARS.

J. Joe Ford is at the USDA-ARS Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933. Phone (402) 762-3241. ♦

Just Off Press

USDA Agricultural Handbook 631, ***Virus Diseases of Small Fruits,*** Richard H. Converse, editor. This 277-page color-illustrated handbook may be purchased for $20.00 from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325.

Safeguarding Our Essential Resource . . . Water

Nationwide, about half of the population gets its drinking water from wells that tap groundwater. Some states are particularly reliant on this underground source. For example, the U.S. Geological Survey reports that 93 percent of the population in Mississippi and 82 percent in Nebraska depend on groundwater.

Overall, the size of the pollution threat to safe drinking water has yet to be defined. Federal and state governments have recently stepped up their monitoring of drinking water. The U.S. Department of Agriculture's Agricultural Research Service is concerned because some farming practices and chemicals used in agriculture could contribute to groundwater pollution. At 14 major research locations throughout the United States, agency scientists are examining potential pollution problems and how to prevent them.

"Our biggest challenge today is not developing new sources of drinking water, but maintaining the purity of those we already have."

David A. Farrell, Agricultural Research Service

Different areas of the country face diverse threats. For example, some soils in California contain natural salts, including those of boron and selenium, that could be flushed by irrigation into groundwater or into surface water. Soils in the East and Midwest, where rainfall is heavier, don't usually have selenium and boron problems, but may still contain pesticide residues or fertilizer-enhanced nitrate levels.

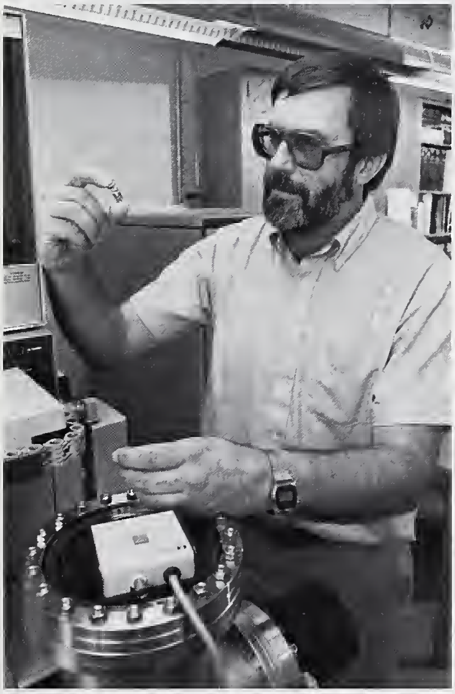
"We need to learn more about naturally occurring salts and applied fertilizers and pesticides and how to minimize their movement into groundwater," says ARS' David A. Farrell, at Beltsville, Maryland. Farrell is national program leader for water quality and an outspoken proponent of groundwater research. He says, "Our biggest challenge today is not developing new sources of drinking water, but maintaining the purity of those we already have."

TIM McCABE

Above: Hydraulic engineer Walter Knisel (seated) and soil scientist Ralph Leonard use the GLEAMS computer program they developed to track possible pesticide leaching into groundwater in the Tifton, Georgia, area. (0786X22-31)

Right, top: In California's Imperial Valley, salt carried onto this field by irrigation water has made it impossible to grow alfalfa. ARS scientists at Riverside are developing irrigation techniques to save fields such as this one while safeguarding groundwater. (CA-7508)

TIM McCABE



DON BRENEMAN

At St. Paul, Minnesota, soil scientist William Koskinen uses a mass spectrometer to identify pesticides in water and soil samples from Minnesota cornfields. Analysis will be fed into a computer model to predict the likelihood of pesticides threatening groundwater. (0687X672-20A)

Soil, Chemical, Weather Combinations Form Complex Problem

Each of the 70,000 kinds of soil in the United States varies in its ability to hold potential pollutants safely in root zones. For example, clay soils tend to retard water and chemical movement, compared to sandy soils, which permit their passage. Many other chemical and physical characteristics of the soil influence how quickly water-soluble chemicals move. These include the amount of organic matter present, temperature, water content, and acidity.

Thousands of different formulations of agricultural chemicals are used in growing food and producing other agricultural products. Each behaves differently in different soils; however, only a small number pose a threat to groundwater. Finding out how they interact in varying amounts and with seasonal distributions of rainfall is a highly complex problem.

Actually mapping every field in the country and monitoring the movement of agricultural chemicals applied to each field is impractical. It would require more money and effort than any research project ever attempted. After all, a single soil analysis for one pesticide costs as much as $150, and there are about 400 million acres under cultivation in the United States that would need to be sampled.

Computers offer a way to organize the piecemeal data collected over the past decades. They can fill in gaps where actual field data is missing and predict what may happen to a specific chemical, on a specific soil, under a range of management conditions. Their success depends on the quality of their information base, plus the scientists' ability to systematically exploit advances in computer technology.

One of the newest and most potentially useful ARS computer programs is GLEAMS (Groundwater Loading Effects of Agricultural Management Systems). It was developed by hydraulic engineer Walter G. Knisel, Jr., and soil scientist Ralph A. Leonard at ARS' Southeast Watershed Research Laboratory at Tifton, Georgia.

Recently, they tested GLEAMS on some fields around Tifton to see how planting dates for field corn affect leaching or downward movement of pesticides.

GLEAMS sorted through 50 years of climate data to select April 15, rather than March 15 or April 1, as least threatening to groundwater supplies. This is because rainfall is less likely to carry chemicals used on the corn beneath the root zone after that date. Knisel says that the long growing season in Georgia allows farmers flexibility in planting dates without materially affecting yields. Adjustments to farming operations may be needed where double-cropping and multiple-cropping are practiced.

In another test in Wisconsin, GLEAMS showed that the safest time to use aldicarb on potatoes is 30 days after they emerge from the soil. This is consistent with current guidelines, which stipulate that the pesticide be applied 3-6 weeks after planting.

Copies of GLEAMS, on floppy disks for IBM and compatible computers, have been made available to public agencies such as USDA's Soil Conservation Service and the U.S. Environmental Protection Agency as well as to agrichemical companies.

An ARS study begun in 1987 in cooperation with state researchers will check the accuracy of some of today's computer simulations. In the process, scientists expect to obtain new data on the potential of four farm pesticides to contaminate groundwater in Minnesota and other midwestern states. William C. Koskinen, with ARS' Soil and Water Management Research Laboratory, St. Paul, leads a study he devised to test a computer model developed by Cornell University scientists. The model, called LEACHM for Leaching Estimation and Chemical Model, paints a picture of pesticide leaching that takes into account differences in rainfall, soils, farmers' ways of tilling the land for soil conservation, timing and rate of pesticide applications, and other practices such as crop rotation to forecast the potential hazard to water supplies.

To test the system, Koskinen and University of Minnesota scientists last May applied three commonly used herbicides and one insecticide to corn plots in three different parts of Minnesota. One site is on the central, sandy plains. A

second site is typical of the heavy silt loams found in the south-central region. The third location in the southeast has shallow soils underlain with limestone. This area, replete with limestone caves, is particularly susceptible to rapid water percolation and thus to pollution.

"We think the LEACHM model will apply across a wide range of geographic areas and cropping practices in the Midwest," Koskinen says. "We want to give farmers practical options for changing their farming methods not only to get good yields while controlling soil erosion, but also to protect groundwater."

In separate, ongoing studies with ARS plant physiologist Edward E. Schweizer at the Sugarbeet Production Research Unit, Crops Research Laboratory in Fort Collins, Colorado, Koskinen is using the same model to learn how chemical movement is affected by irrigation.

Fertilizer a Pollutant if It Leaves the Root Zone

Although nitrogen gas makes up the greatest part of the atmosphere, most crops must get their nitrogen from mineral forms (ammonium and nitrate) in the soil. These plant-usable forms of nitrogen are derived from breakdown of soil organic matter, fixation of atmospheric nitrogen by bacteria, recycling from plant residues and animal wastes, weathering of soil minerals, and fertilizers.

"Because nitrogen fertilizer can be a source of groundwater pollution under certain combinations of soil, nitrogen applied, plant nitrogen uptake, water management, and weather, we want to learn how to keep it in the crop root zone where plants can use it and not have it seep into water supplies," says Ronald Follett, soil scientist and research leader for ARS' Soil-Plant-Nutrient Research Unit, Fort Collins.

Follett's research team is looking at chemical and biological factors that affect nitrogen transformations in the soil-plant system.

Because nitrate dissolves readily in water and is not held on soil particles, it is free to move through the soil profile whenever excess water moves downward and nitrate exceeds the demands of growing plants. Leaching of large quantities into groundwater puts animal and human water users at risk. Water containing more than 10 parts per million of nitrate is considered by health authorities to be unsafe for human consumption.

Certain micro-organisms in the soil can convert nitrate to nitrogen gas (denitrification), which can then escape harmlessly into the atmosphere. Soil scientist Wayne Guenzi and chemist Arvin Mosier are conducting research in Fort Collins to determine whether conditions exist in soil layers below the root zone for the possible chemical and microbial conversion of nitrate to nitrogen gas.

The research, thus far, has been inconclusive. Soil samples collected below the root zone and subjected to an oxygen-free atmosphere in the laboratory show that nitrate is changed to gaseous products in some samples but not in others. The large variability appears to be associated with seasonal and soil property differences.

Sometimes nitrate builds up in soils even without human or agricultural intervention. For example, large quantities of geologic nitrogen have been found within the deep loess mantle of southwestern and central Nebraska. Deposits such as this one, which overlies parts of the High Plains Aquifer, make environmental impacts of fertilizers, sewage, and industrial wastes on groundwater more difficult to assess.

ARS scientists, in cooperation with other USDA agencies, have demonstrated to farmers in Hall County, Nebraska, that they could cut nitrogen fertilizer application rates by about one-third, or 80 pounds per acre, and still get the same corn yields. This savings was achieved by merely following existing guidelines for fertilizer application and using a scheduling program for applying irrigation water.

Earlier work has shown that nitrate content may decrease as the water carrying it passes through root zones. But the process is complex and has not been fully understood. To obtain actual field data, ARS microbiologist Timothy Parkin, in conjunction with the University of Maryland Wye Research and Education Center, is analyzing water samples drawn from test wells at three agricultural field sites near the eastern shore of the Chesapeake Bay in Maryland. Each field site is abutted by three kinds of surface buffer zone: grassland, forest, and marsh.

Parkin has pointed out several natural processes that may be responsible for the lowering of nitrate: Nitrate may be directly extracted from soil by root systems, it may be transformed into gas by microbes that dwell around plant roots, or it may be diluted by the deep drainage waters from lands that have not been farmed. Preliminary sampling suggests that these natural purifying processes may offer hope to clear up nitrate pollution in shallow groundwater.

Other locations where ARS is studying ways to prevent groundwater pollution include:

• U.S. Water Conservation Laboratory, Phoenix, Arizona. Scientists are developing procedures that predict downward movement of water. Preliminary work suggests that previous assumptions on water movement are in error in some soil and tillage situations. Further research will indicate how current farming practices need to be modified to minimize movement of agricultural chemicals to groundwater.

• U.S. Salinity Laboratory, Riverside, California. Scientists have demonstrated how to optimize water use through recycling, so that it's now possible to recover irrigation water after it's been used and use it a second time on crops that are more salt tolerant. This strategy concentrates salts found naturally in soils, so that after the final irrigation, the salt-laden water must be diverted into evaporation ponds where the salts precipitate and are kept from groundwater. ARS scientists in the Water Management Unit at Fresno, California, are also interested in recycling water and seek to develop more efficient irrigation systems.

• Central Great Plains Research Station, Akron, Colorado. Scientists study how different tillage practices and rainfall affect herbicide movement in soil. They have also developed rapid and inexpensive tests to detect selected pesticides at concentrations of less than 1 part per billion.

• Northern Regional Research Center, Peoria, Illinois. Researchers at this

TIM McCABE

TIM McCABE

Above: On Maryland's Eastern Shore, microbiologist Tim Parkin takes groundwater samples from well sites adjacent to cropland along the Wye River. The samples will be studied to determine the amount of nitrogen that leaches into the groundwater, and ultimately the river, from farmland. (88BW0060-34)

Left: ARS chemist Philip Kearney and soil scientist Charles Helling take groundwater samples from a test site next to cropland at Beltsville, Maryland. They are studying the effect of different tillage methods on the movement of pesticides into groundwater. (1086X1116-9)

facility and at other ARS field locations are working to develop and confirm the potential for using slow-release herbicides for controlling weeds while protecting groundwater. (See box p.10)

• Soil and Water Research, Baton Rouge, Louisiana. Researchers are studying the persistence, breakdown, and movement of pesticides in agricultural ecosystems.

• Beltsville Agricultural Research Center, Beltsville, Maryland. One groundwater project involves ways to break down pesticides into harmless compounds before they contact any surface or underground water supplies. Recently, chemist Philip C. Kearney discovered certain bacteria produce enzymes that break down pesticides. Scientists in his biotechnology group have isolated three important genes responsible for enzymes that degrade a large number of pesticides.

Widespread recent interest in conservation tillage farming practices has led Beltsville scientists to examine if these farm practices have any impact on pesticide leaching. An extensive field study, begun in 1986, is comparing soil and groundwater pesticide levels for no-till and conventional till (moldboard plowing) test sites. According to soil scientist Charles S. Helling, over a hundred wells have been installed at Beltsville, affording a fine opportunity to sample shallow groundwater beneath the experimental acreage.

• Southern Weed Science Laboratory, Stoneville, Mississippi. Among projects conducted here, soil scientists such as Sidney S. Harper and Thomas B. Moorman are focusing on other unknowns of conservation tillage. They are looking to see whether this farming practice can cause changes in soil chemistry, microbiology, and water-holding characteristics of the soil. Such changes could, in turn, change the rate that pesticides are held by—or released from—soil particles.

• Soil and Water Conservation Research Unit, Lincoln, Nebraska. Scientists are studying the nitrogen mineralization process so that fertilizer can be applied to crops with precision. "It's possible that we can develop a technique to quickly and reliably test plants for their nitrogen needs," says James S. Schepers, ARS soil scientist at Lincoln. "Then, if more is needed, it could be mixed with the next irrigation water. This could prevent overdoses sometimes applied at planting time."

• Applications Technology Research, Wooster, Ohio. Today's spraying techniques may not be the most environmentally sound ways to apply pesticides. Because some current application techniques result in less than 5 percent of the pesticide reaching its target, Wooster scientists are developing new spraying concepts and additives that can make

pesticides stick to their target. The result—less leaching into groundwater, not to mention cost advantages, thanks to reduced waste.

• Water Quality Research, Durant, Oklahoma. Scientists are striving to find better ways to predict the environmental impact of agricultural chemicals. Soil scientist Samuel J. Smith says that at ARS-operated test farms in different watersheds of the southern plains area, a variety of planting and tillage practices are being evaluated in terms of groundwater and surface water contamination.

• Northeast Watershed Research Laboratory, University Park, Pennsylvania. Scientists are developing ways to protect both surface and groundwater.

—By **Dennis Senft,** ARS. **Linda Cooke** and **Regina Wiggen** of ARS contributed to this article.

David A. Farrell is National Program Leader for Water Quality for USDA Agricultural Research Service. His address is Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20205. Phone (301) 344-4246. ♦

Surplus Starch Key To Reducing Herbicide Use

Starch from the nation's reserves of surplus corn may be one way to reduce possible threats to groundwater in U.S. agricultural areas.

In a process developed by Agricultural Research Service scientists, starch can be mixed with herbicides to make them into timed-release granules. If these encapsulated chemicals replace direct applications now used, it could mean cleaner groundwater and surface water, since the granules are less susceptible to losses by leaching, surface runoff, and evaporation.

Smaller amounts of herbicide would be required to kill weeds, and the encapsulated material would be easier and safer to handle than spray formulations.

Co-inventors of the process are chemists William M. Doane and Robert E. Wing of USDA-ARS Northern Regional Research Center, Peoria, Illinois, and Sukumar Maiti, who has since returned to the Indian Institute of Technology, Kharagpur, India.

The process involves cooking the main ingredient, cornstarch, in a jet of steam to gelatinize the starch particles. Then herbicide is added. After mixing and drying, it crumbles into free-flowing granules that are riddled with microscopic holes filled with pesticide.

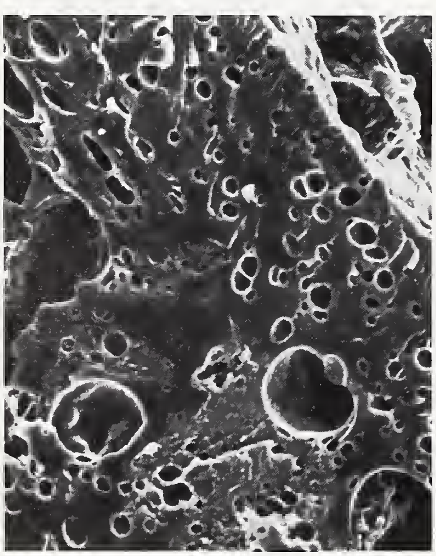
When an encapsulated herbicide granule is moistened, its starch slowly swells. Water seeps into the holes, gradually emptying them of the weed killer, which is then carried to the soil.

Starch components, such as amylopectin and amylose, swell at different rates, so the built-in rate of weed-killer release can be adjusted. When granules contain more amylose than amylopectin, herbicide release is slowed.

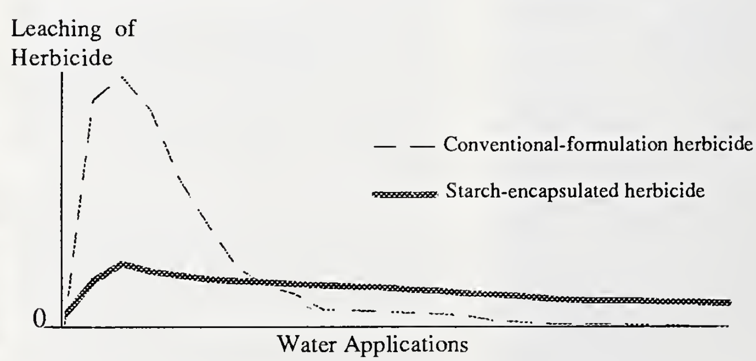
Agency scientists at Peoria and West Lafayette, Indiana, are conducting greenhouse and field tests in cooperation with Purdue University.

A patent was applied for on the process in July 1987. Currently, two companies are exclusively licensed to make time-release products using an earlier ARS starch-based encapsulation process.

To make herbicide applications last, farmers must often apply much more chemical than is initially required. Although this excess affords a reserve concentration to protect against future weeds, it adds to the risk of groundwater contamination. Timed-release pesticides show promise of bringing farmers' weed control practices in sync with their heightened awareness of groundwater stewardship.—**R.W.**



LEE BAKER



Above: Starch-encapsulated formula releases herbicide much slower than a conventional formulation and would stay effective against weeds longer if applied at the same rate. Source: Robert E. Wing, USDA-ARS Northern Regional Research Center.

Left: Highly magnified cross section of starch-encapsulated herbicide granule reveals tiny openings where liquid herbicide was entrapped for slow release. (PN-7273)

Asian Children May Quell Nutritional Controversy

One in four grade-school-age children in northeast Thailand—the poorest part of that country—falls significantly below normal for zinc and vitamin A levels in the blood. Mild deficiency in either of these nutrients can mean more illnesses due to lowered resistance to diseases. Too little zinc can impair growth and development and too little vitamin A can cause night blindness—

"Although the study will include [vitamin and mineral] supplements, they aren't the solution. Agricultural experts will have to help local people produce foods that supply these nutrients."

Emorn Udomkesmalee, Thailand Nutrition Researcher

the inability to see in dim light or darkness because black-and-white vision is impaired.

Thai nutrition researcher Emorn Udomkesmalee has spent a year at the Agricultural Research Service's Vitamin and Mineral Nutrition Laboratory in Beltsville, Maryland, analyzing blood samples from northeast Thailand to identify children who have low levels of both nutrients. With the preliminary part of the study complete, the question now is: Can adequate zinc also correct problems associated with mild vitamin A deficiency?

Twelve years ago, before James C. Smith came to Beltsville as chief of the ARS laboratory, he found that zinc is necessary for vitamin A to function normally. In other words, a zinc deficiency can cause an apparent vitamin A deficiency. "Zinc seems to be necessary for the body's use of vitamin A," says Smith, and it is also involved in distributing the vitamin to the tissues that require it. The findings have been corroborated in rats and monkeys and in malnourished people, he says, but no one has adequately answered the extended question in humans: If zinc is a limiting factor in vitamin A metabolism, will adequate zinc alone improve the effectiveness of vitamin A?

Thailand provides an ideal setting for answering the question. "A marginal intake of vitamin A is one of the major nutritional problems in my country," says Udomkesmalee. "We don't have widespread blindness due to severe vitamin A deficiency, but we commonly see early symptoms such as night blindness in some villages in northeast Thailand." Not only is night blindness fairly specific for vitamin A deficiency, she says, it can be measured. In fact, she spent some of her time here learning a rapid technique for detecting early stages of vitamin A deficiency at the Johns Hopkins Wilmer Eye Institute in Baltimore.

Udomkesmalee is back in Thailand setting up a modern trace element laboratory at the Institute of Nutrition, Mahidol University, in Bangkok. She is also training institute personnel on sample collection and analysis. With joint funding from the Office of International Cooperation and Development and ARS, Smith visited the institute and villages in northeast Thailand in October and November of 1987 to help work out details for the study, which will look at the interaction between zinc, vitamin A, and the immune system in maintaining health.

The two scientists expect findings will help provide the rationale to plan for a community nutrition program. "Although the study will include supplements, they aren't the solution," says Udomkesmalee. "They're okay for immediate treatment of deficiencies, but for prevention, we'll have to rely on local food sources. Agricultural experts will have to help local people produce foods that supply these nutrients." The people in northeast Thailand now subsist mainly on rice, she says, with some chili peppers and fermented or dried fish.

According to Smith, the study may also help resolve the controversy over whether the U.S. diet is adequate in zinc and vitamin A by providing information about the minimum daily requirement for these nutrients.

A second ARS researcher, nutritionist Tim R. Kramer of ARS' Grand Forks, North Dakota, Human Nutrition Research Center, is proposing to visit Thailand before the children are given

TIM McCABE

ARS biochemist James Smith and Thai nutrition researcher Emorn Udomkesmalee study blood data on children from Northeast Thailand to identify those with low levels of zinc and vitamin A. (0787X758-9)

supplements and again after they have been taking them for 6 months to look for differences in their immune response. Since the children will be divided into four groups—those getting zinc alone, vitamin A alone, both nutrients, or neither nutrient, it should answer the question: Does their susceptibility to infections stem from inadequate zinc, vitamin A, or both?

The state of nutrition in Thailand provides an ideal opportunity for studying the effects of such mild deficiencies and, hopefully, this binational effort will provide insight to ensure optimum health through good nutrition.—By **Judy McBride,** ARS.

James C. Smith is in the USDA-ARS Vitamin and Mineral Nutrition Laboratory, Room 117, Bldg. 307, Beltsville Human Nutrition Research Center, BARC-East, Beltsville, MD 20705. Phone (301) 344-2022. ♦

New Plow Saves Soil, Harnesses Microbe Power

An underground plow originally designed to pulverize hard, thin planes of soil in dryland wheat-growing regions may become a boon to conservation tillage farmers, says an Agricultural Research Service scientist.

The new tillage tool, invented by soil scientist Lloyd N. Mielke and colleagues at the University of Nebraska, should benefit producers of rain-fed row crops such as corn and soybeans by saving soil and water and exploiting microbial activity. Mielke is patenting a sweep plow he modified by attaching four steel shanks underneath to break up the soil.

Since the great drought of the 1930's, the sweep plow has been a mainstay of Great Plains wheat growers for subsurface tillage of fallow or bare fields. A sweep is a flat V-shaped blade with a "wingspan" up to 5-1/2 feet. In operation, the blade is pulled horizontally through the soil, point first, about 3 to 4 inches below the surface.

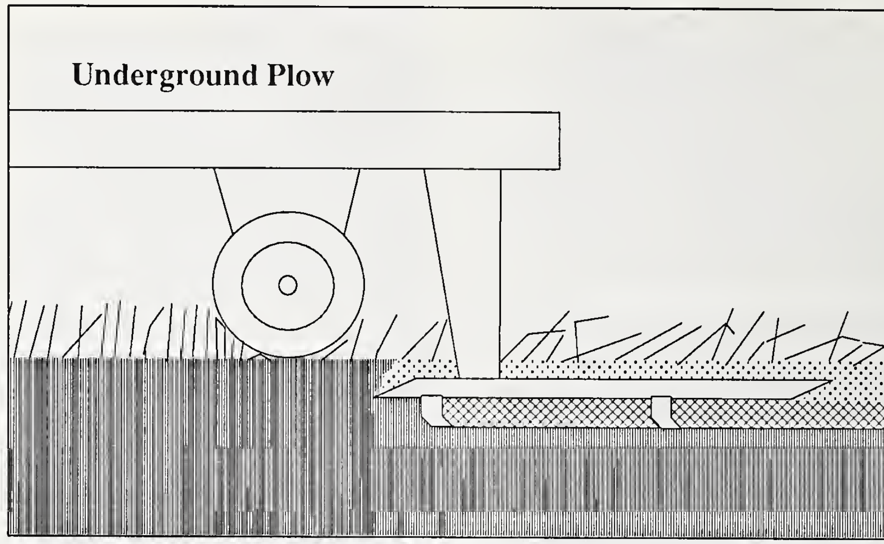
The sweep plow undercuts emerging weeds and loosens the soil layer above the blade. It does this without greatly disturbing a surface layer of crop residue maintained to slow evaporation of scarce rainfall. On the negative side, the blade's bottom edge "shears off the soil," Mielke says. "The sheared soil plane looks as though someone smeared it with a giant putty knife, closing up root and worm holes and similar cracks and openings."

Eventually the shear plane may become a virtually impenetrable barrier. It curbs infiltration of water, deprives beneficial microbes of oxygen, forces roots to grow sideways, and may cut crop yields.

To remedy these problems, Mielke attached 6-inch-long steel shanks to the underside of the sweep blade. After many trials involving positioning and bending of the shanks, he came up with a workable system.

In Mielke's design, two shanks are attached under each side of the V-blade. The shanks incline toward the center so that as they travel forward their geometry of bends and twists thoroughly breaks up the soil to a depth of 8 to 10 inches, leaving it porous, well aerated, and mellow.

"Basically, the modified sweep plow does what a moldboard plow does, except it keeps crop residue where it belongs, on the surface," Mielke says.



Modified from existing sweep plows, the underground plow loosens soil and increases water-holding capacity, yet leaves crop residues on the surface to cut erosion. (Not to scale.)

That noninversion feature could make Mielke's plow useful for corn and soybean production in regions of heavier rainfall. Farmers practicing conservation tillage (also called minimum tillage) sometimes need to plow to break up soil compacted by machinery traffic, for example, or to disrupt the buildup of weeds, insects, or diseases. However, moldboard plows bury crop residue, increasing soil erosion potential.

Using a modified sweep plow for those purposes would save crop residue to fight erosion. The residue blanket plays three key roles in managing water: It prevents crusts that limit infiltration, it slows evaporation, and it enables soil to take in more water and thus reduces erosion by surface runoff.

It's easier for water to seep into soil made porous by modified sweep tillage than to infiltrate denser conservation-tilled soil, Mielke notes. And sweep-tilled soil stores more water for crop growth. The water is trapped in subterranean reservoirs, a series of troughlike corrugations that the shanks create just below the tilled zone.

Porous soil helps foster microbial activity that unlocks extra nutrients for crops. Soil pores must hold a proper balance of water and air if microbes are to make nutrients available for plant nourishment. Earlier research at Lincoln by ARS soil scientist John W. Doran showed that when about 60 percent of the soil pore spaces are filled with water, conditions favor the aerobic, or oxygen-loving, microbes that decompose organic matter and release nitrogen, which becomes available to the crop.

By contrast, when pore space filled with water exceeds 80 percent, anaerobic microbes thrive. They waste plant-available nitrogen, whether from organic matter or commercial fertilizer, converting it into gases that escape into the atmosphere. Tests indicate that soil porosity in the lower part of the sweep-tilled zone creates a water and oxygen status that is ideal for aerobic microbial life, Mielke says.

In typical field use, three sweep plows are aligned and pulled abreast. Modified sweeps require more than twice as much tractor drawbar power as sweep blades alone. It is possible to scale down the modified sweeps for small farms by using a single sweep, even one that is under 5 feet, if desired.

Mielke developed the sweep plow with assistance from soil scientist Alice Jones and agricultural engineer Leonard Bashford. Both are with the University of Nebraska, Lincoln.

Some refinements to the system need to be made. Mielke says, "Soil can't be too wet; if it is, it won't fracture."

Mielke envisions a tillage system that always keeps crop residue and organic matter on and near the surface, soil conditions that the first settlers encountered when they began farming the prairies.

"Those soils had excellent structure and aeration, and they teemed with microbial life," he says. "We should try to manage our soil systems to help them approach a more natural state."—By **Russell Kaniuka,** ARS.

Lloyd N. Mielke is in USDA-ARS Soil and Water Conservation Research, East Campus, University of Nebraska, Lincoln, NE 68583. Phone (402) 472-1516. ♦

Rural Information Center

The U.S. Department of Agriculture's National Agricultural Library and Extension Service have jointly established a Rural Information Center (RIC), designed to serve as an information source for local government officials working to maintain the vitality of America's rural areas.

The Center combines the technical, subject-matter expertise of Extension's nationwide educational network with the resources of an extensive agricultural library.

The information and services available through RIC will be accessible to local governments through Extension's county and State offices.

The Center will supply information on maintaining a competitive rural economy; the natural resource base; and rural services, facilities, and support. It will offer four different services: information and referral, consultation, annotated bibliography, and future trends.

A pilot system is to be tested in six states starting January 1988.

For more information about Rural Information Center, contact its coordinator, Patricia John, Room 304, NAL, Beltsville, MD 20705. Phone (301) 344-3704), or Robert Lovan, National Program Leader, Natural Resources and Rural Development, Extension Service, USDA, Room 3869-S, Washington, DC 20250. Phone (202) 447-2506. ♦

Fungi Are Key Future Sources of Safe Chemicals

If the Irish of the 1840's had known about a fungus called *Penicillium cyclopium*, the potato famine might never have happened.

This fungus produces a chemical antibiotic, cyclopenol, that stymies another fungus *(Phytophthora infestans)*, that caused the Irish potato blight, says Agricultural Research Service plant physiologist Hank Cutler. He discovered in lab studies that cyclopenol is 95 percent effective in stopping the potato blight fungus' growth.

The blight virtually wiped out the Irish potato crop in 1845-46. A million Irish died from starvation and malnutrition, and a million and a half more were forced to emigrate to the United States and other countries.

Growers today use chemicals to control *P. infestans*, but chemicals are costly, and the fungus can develop resistance to them. Despite availability of modern-day controls, the International Potato Center in Peru ranks it as the worst potato disease worldwide.

So cyclopenol and other natural chemicals are gaining increased attention, says Cutler. "Cyclopenol has great potential as a natural fungicide. It could join the list of fungal chemicals that have already proved effective in repelling disease-causing organisms, regulating plant growth, and serving as human drugs similar to penicillin. Natural compounds hold great promise because they work against specific targets, are extremely potent, and aren't hazardous to the environment, because they're biodegradable."

Working at the agency's Richard B. Russell Research Center in Athens, Georgia, Cutler grows fungi in his laboratory and studies the effect of compounds they produce. Little is known about how fungi create these compounds.

"Our findings are preliminary, and industry would have to conduct further studies to confirm them," he says. "We're cooperating in our research with several national and international chemical companies that are interested in what we've found.

Other fungal products:

• Cyclopenin, also produced by *P. cyclopium*, has potential as a plant growth regulator. In other studies, 250 milligrams of cyclopenin made chicks drowsy and 500 milligrams completely tranquilized them. Cutler says it is similar to Valium and has potential as a drug.

• Cytochalasin H, produced by a *Phomopsis* fungus. At various concentrations, it inhibited the growth of tobacco seedlings from 53 to 87 percent after 28 days in greenhouse tests. It also delayed flowering for 6 weeks in tobacco seedlings in the greenhouse. "This has great potential as a growth regulator and could replace costly and time-consuming hand labor in the field," Cutler says. "Often workers have to cut back up to 7,000 plants per acre to prevent premature flowering."

• 6-pentyl-pyrone, from the fungus *Trichoderma viride*, inhibited the growth of *Aspergillus flavus* in laboratory studies. Under certain environmental conditions, *A. flavus* grows on grains and other field crops and produces aflatoxin, a potent carcinogen. The United States closely regulates aflatoxin levels in food to ensure that it doesn't enter the food supply, but it is more of a problem in developing countries where controls are not as strict. "6-pentyl-pyrone could be sprayed on stored commodities (corn, peanuts, sunflower seeds) to suppress the growth of *A. flavus*," he says. "This could reduce or eliminate aflatoxins."

• Tentoxin, a fungal toxin, is a chemical model for new compounds that control weeds such as johnsongrass, mustard seed, barnyard grass, and morningglory. Judson V. Edwards at the ARS Southern Regional Research Center in New Orleans, Louisiana, has developed peptide chemicals that are based on tentoxin. In laboratory studies, the peptides killed these weeds without harming corn or soybeans. Alan R. Lax and Hurley Shepherd, also at the research center, are studying how these peptides work and are developing genetic engineering techniques to make fungi produce them more efficiently.—By **Sean Adams,** ARS.

Hank Cutler is at the USDA-ARS Richard B. Russell Research Center, P.O. Box 5677, Athens, GA 30613. Phone (404) 546- 3378. ♦

Spiroplasmas Tempted by Laboratory "Soup"

Kevin J. Hackett runs a "soup kitchen" for spiroplasmas and mycoplasma-like organisms—bacteria that are blamed for hundreds of crop diseases and are of considerable interest to medical researchers.

Spiroplasmas are corkscrew- or wave-shaped parasites that lack cell walls and inhabit more than 100 insect and tick species and some plants. Many are hard to keep alive outside their hosts and therefore nearly impossible to reproduce for extended research.

Enter Hackett, an insect pathologist at the Agricultural Research Service. He and colleagues brew special soups—laboratory culture mediums—to support studies of the microbes' nutritional needs and genetic structure.

Hackett is one of the half-dozen or so ARS scientists and one of about two dozen people worldwide who study spiroplasmas.

"We call spiroplasmas fastidious parasites because they usually become sluggish or die if a culture medium isn't just right," he says. His soup kitchen in the agency's Insect Pathology Laboratory, Beltsville, Maryland, keeps more than 30 spiroplasma species thriving, along with other bacteria that lack cell walls.

"One spiroplasma that infects female fruit flies attacks the male zygotes—fertilized eggs that will become males," he says. "Another spiroplasma kills honey bees. Still others cause diseases in corn, citrus, and other crops."

Some spiroplasmas seem harmless to their insect hosts—such as Colorado potato beetles, which damage eggplant, potato, and tomato crops—but spiroplasmas theoretically could be bioengineered to attack such pests.

Perhaps the strangest spiroplasma is one that infects rabbit ticks. "The rabbit-tick spiroplasma has baffled animal and medical researchers since the early 1960's," Hackett says.

Isolated in 1961 but not correctly identified until 1976, it is the latest of three spiroplasmas for which Hackett and laboratory colleagues have developed culture mediums. The new medium is a precise mix of 80 ingredients: salts, organic and amino acids, carbohydrates, fats, vitamins—even penicillin "to protect the rabbit-tick spiroplasma from enemy bacteria," he says.

Microscopic view of a spiral-shaped spiroplasma that lives in the Colorado potato beetle. Someday, this parasite may be genetically altered to attack its host. (PN-7252)

While of little agricultural interest, this is probably one of the more studied spiroplasmas. Medical and animal researchers outside the Agricultural Research Service have shown it can take over the machinery of animal cells and cause tumors when experimentally injected into laboratory animals. But no one has ever found any spiroplasma in an animal or human.

Still, research on the rabbit-tick spiroplasma could take off now that its nutritional needs are defined. Older culture media, with hundreds of ingredients in varying amounts and unknown composition, often biased the results of experiments.

Spiroplasmas, at six millionths of an inch across, rank among the world's smallest organisms—500 times thinner than a human hair, Hackett says.

Under a microscope, a spiroplasma can be seen stretching out and pressing together and sometimes tumbling end over end like a child's toy, the Slinky. Some spiroplasmas dangle from microvilli, finger-shaped extensions of an insect host's gut cells. Others move around in an insect's blood and invade its cells.

The scientists are now trying to brew a medium for a "mycoplasma-like organism," which is not a spiroplasma but another type of bacterium without a cell wall. Mycoplasma-like organisms cause "hundreds of crop diseases and are spread from plant to plant by the leafhoppers they infect," he says.

TIM McCABE

In his Beltsville laboratory, insect pathologist Kevin Hackett mixes some 80 nutrients into a medium that will support the growth of spiroplasmas outside of their hosts. (1287X1343-20)

Scientists at the insect laboratory are working in cooperation with researchers at the National Institutes for Health (NIH) and the Food and Drug Administration to design a culture medium for *Mycoplasma pneumoniae*, the bacterium that causes walking pneumonia in humans. The NIH researchers want better diagnostic tests for the disease.

Some support for Hackett's research comes from the U.S.-Israel Binational Agricultural Research and Development Fund. The fund, which today supports about 120 projects, was established by the two countries in 1977 to support agricultural research and development for their mutual benefit. Cooperating in Hackett's studies is Dr. Shlomo Rottem of the Hebrew University of Jerusalem.—By **Jim DeQuattro,** ARS.

Kevin J. Hackett is at the USDA-ARS Insect Pathology Laboratory, Bldg. 011A, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Phone (301) 344-3086 ♦

Potato Plants Make Their Own Insect Repellent

Two years of biotechnology research by U.S. Department of Agriculture scientists have resulted in the first hybrid potato plants with an insect repellent built into their leaves.

They contain a rare gene for leptine, a chemical that repels insects, says Stephen L. Sinden, leader of a team of Agricultural Research Service scientists that produced the hybrid potatoes.

The scientists put the leptine gene into potatoes by fusing single cells from wild and commercial potato plants then growing the fused cells into hybrid plants.

Cell fusion is a method of genetic engineering that is different from gene splicing or recombinant DNA. In cell fusion, the genes, made up of the hereditary molecules of DNA, remain intact.

"The advantage of cell fusion," Sinden says, "is that we know not only that the fusion hybrids have the desired genes but also that the genes are likely to be expressed in the plants."

With the potato hybrids, this advantage could help breeders develop insect-resistant varieties within several years.

Leptine in the leaves repels the most devastating pest in U.S. potato fields, Sinden says. "The beetles land on the hybrid plants as usual. They peel back a little skin on leaves and nibble, but then fly away. The plants are barely touched."

In recent years, the beetles have developed tolerance to insecticides that farmers continue to spray at an annual cost of over $120 million.

The hybrid plants produce much larger potatoes than do the wild potato plants—almost half the size of commercial potatoes, Sinden says.

"We're also pleased that the fusion hybrids are fertile, that they can be crossbred to improve tuber (potato) yield and quality," he says.

Leptine is a glycoalkaloid that may be toxic to humans in large doses. However, Sinden says, the hybrid plants make leptine only in the leaves, not in the potatoes.

The gene for leptine is in only one of a thousand types of wild potato plants. To find the gene, Sinden's team screened 800 wild plants from one of the world's premier collections of research potatoes, ARS' Inter-Regional Potato Introduction Station, Sturgeon Bay, Wisconsin.

TIM McCABE

Above: Colorado potato beetles take only a bite or two of this insect-resistant potato plant before they are repelled. The plant has been genetically engineered to contain a rare gene from wild potatoes that produces leptine in the leaves. (0687X533-22)

TIM McCABE

Right: ARS plant pathologist Kenneth Deahl finds Colorado potato beetles have done little damage to new insect-resistant potato plants. (0687X534-11)

Sinden's team found that leaves of a few plants of a wild species called *Solanum chacoense* have high levels of leptine. Researchers used enzymes to dissolve bits of the leaves into millions of single cells in a laboratory dish. Another treatment removed the cell walls, natural barriers to plant cell fusion.

The scientists repeated the process to produce a second dish of wall-less cells from a commercial variety called Saco. They poured both dishes of naked cells into a beaker of chemicals that forced close contact.

Only about 1 percent fused, mixing their genes, says Sinden, but in all the hybrid plants, the leptine gene from *S. chacoense* became integrated with the DNA from Saco.

The agency team includes plant pathologist Kenneth L. Deahl, geneticist Lind L. Sanford, entomologist William W. Cantelo, and Sinden, a plant physiologist, all at the Beltsville (Maryland) Agricultural Research Center, and chemist Stanley F. Osman at the Eastern Regional Research Center in Philadelphia, Pennsylvania.—By **Stephen Berberich,** ARS.

Stephen L. Sinden is at the USDA-ARS Vegetable Laboratory, Bldg. 004, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Phone (301) 344-4507. ♦

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PATENTS

Protecting Chickens Against Marek's Disease

Vaccines have been used since 1970 to protect from Marek's disease the 4 billion chickens raised in the United States annually. Nevertheless, the poultry industry continues to experience losses from this virally transmitted disease, which is characterized by the development of tumorous lesions in infected birds. One reason for these losses is the recent appearance of more virulent strains of the virus.

A new vaccine has been developed which offers better protection against the virulent strains. It uses a specially selected nonpathogenic strain, classified as serotype 2, to combat the disease caused by its pathogenic, and deadly, cousins.

The new vaccine can be replicated rapidly. This makes for stronger protection in the chicken and a vaccine that is easier to produce in vitro. The vaccine is designed to be combined with a turkey herpes virus vaccine.

For technical information, contact Richard L. Witter, USDA-ARS Regional Poultry Research Laboratory, 3606 East Mount Hope Road, East Lansing, MI 48823. Phone (517) 337-6828. *Patent Application Serial No. 07/071,949, "Serotype 2 Marek's Disease Vaccine."*

Cellulose III Cotton Fiber Resists Abrasive Wear

The quest to improve on nature has led scientists to such well-known innovations as durable-press, fire-resistant, and stain-release finishes for cotton textiles. One of the latest fibers developed in the laboratory is a rare crystalline form of cellulose that promises to improve durable-press cotton's resistance to wear. The fiber, derived from native cotton and termed Cellulose III, also affords good permeability to dyes, pigments, and other textile chemicals, a help in dyeing and processing.

The fiber begins as plain cotton cellulose, selected from fiber, yarn, or fabric. It is treated with ammonia vapors at high temperature and pressure until its crystalline structure changes. Interatomic distances within the fiber are altered, converting the original Cellulose I into a new, highly stable crystalline form of Cellulose III. The changes in geometric configuration can be observed by X-ray diffraction.

Crystalline Cellulose III can itself be immersed in ethylenediamine and then boiled in dimethylformamide. This will convert it to Cellulose IV, yet another crystalline configuration of interest to scientists; it is stable for only a short period of time before reverting to its original form.

Although laboratory methods for producing these crystalline substances are too costly for manufacturers, less expensive ways to mass produce the substance are being sought. Since Cellulose III can add strength to durable-press cottons, it may be a component of tomorrow's cotton durable-press fabrics.

For technical information, contact Timothy A. Calamari or Lawrence Yatsu, USDA-ARS, Southern Regional Research Center, 1100 Robert E. Lee Blvd., P.O. Box 19687, New Orleans, LA 70179. Phone (504) 286-4265. *Patent Application Serial No. 07/063,357, "Stable Crystalline Cellulose III Polymorphs."*

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